CLAIMS

1. A thermal processing apparatus comprising:

a processing container for containing an object to be processed,

a plurality of heaters for heating the object to be processed,

a plurality of temperature sensors for respectively detecting temperatures at a plurality of predetermined positions in the processing container,

a storing part that stores: a thermal model for forecasting a temperature of the object to be processed contained in the processing container from outputs of the plurality of temperature sensors, and a recipe in which a desired temperature of the object to be processed is defined, and

a controlling part that forecasts a temperature of the object to be processed by using the outputs of the plurality of temperature sensors and the thermal model, and that controls the plurality of heaters so as to cause the forecasted temperature of the object to be processed to coincide with the desired temperature of the object to be processed defined in the recipe,

wherein

the thermal model is configured to forecast, from the outputs of the plurality of temperature sensors, not only a temperature of the object to be processed contained in the processing container but also a temperature of at least one other predetermined portion in the processing container,

a desired temperature of the predetermined portion is also defined in the recipe, and

the controlling part is adapted to forecast a temperature of the object to be processed and a temperature of the predetermined portion by using the outputs of the plurality of temperature sensors and the thermal model, and to control the plurality of heaters so as to cause the forecasted temperature of the object to be processed and the forecasted temperature of the predetermined portion to respectively coincide with the desired temperature of the object to be processed and the desired temperature of the predetermined portion defined in the recipe.

2. A thermal processing apparatus according to claim 1, wherein

an inside heater is arranged in the processing container as one of the plurality of heaters, and

the at least one other predetermined portion in the processing container includes the inside heater in the processing container.

3. A thermal processing apparatus according to claim 1 or 2, wherein

the at least one other predetermined portion in the processing container includes a predetermined portion of an inside wall surface of the processing container.

4. A thermal processing apparatus according to claim 1, wherein

an upper heater and a lower heater are arranged correspondingly to an upper portion and a lower portion of the object to be processed contained in the processing container, as two of the plurality of heaters, and

the at least one other predetermined portion in the processing container includes the upper heater and the lower heater.

5. A thermal processing apparatus according to claim 4, wherein

a gas-discharging pipe is connected to an upper portion of the processing container, and

the upper heater is arranged so as to surround the gas-discharging pipe.

6. A thermal processing apparatus according to claim 1, wherein

an upper heater and a lower heater are arranged correspondingly to an upper portion and a lower portion of the object to be processed contained in the processing container, as two of the plurality of heaters,

an upper temperature sensor is arranged between the object to be processed contained in the processing container and the upper heater, as one of the plurality of temperature sensors, and

the at least one other predetermined portion in the processing container includes the upper temperature sensor and the lower heater.

7. A thermal processing apparatus according to claim 6, wherein

a gas-discharging pipe is connected to an upper portion of the processing container, and

the upper heater is arranged so as to surround the gas-discharging pipe.

8. A thermal processing apparatus according to claim 1, further comprising

a unit of introducing a gas to a gas-introducing port of the processing container, and

a unit of discharging the gas from a gas-discharging port of the processing container,

wherein

the at least one other predetermined portion in the processing container is set between the gas-introducing port and a portion on the most downstream side of the object to be processed, along a path from the gas-introducing port to the gas-discharging port.

9. A thermal processing apparatus according to any of claims 1 to 8, wherein

the thermal model is configured to forecast, from the outputs of the plurality of temperature sensors during a thermal process, a temperature of the object to be processed contained in the processing container during the thermal process and a temperature of the at least one other predetermined portion in the processing container during the thermal process,

a desired temperature of the object to be processed during the thermal process and a desired temperature of the predetermined portion during the thermal process are defined in the recipe, and

the controlling part is adapted to forecast a temperature of the object to be processed during the thermal process and a temperature of the predetermined portion during the thermal process by using the outputs of the plurality of temperature sensors and the thermal model, and to control the plurality of heaters so as to cause the forecasted temperature of the object to be processed and the forecasted

temperature of the predetermined portion to respectively coincide with the desired temperature of the object to be processed during the thermal process and the desired temperature of the predetermined portion during the thermal process defined in the recipe.

10. A thermal processing apparatus according to claim 1, further comprising

a loading/unloading unit that loads an object to be processed into the processing container and, that unloads the object to be processed from the processing container after a thermal process.

11. A thermal processing apparatus according to claim 10, wherein

the thermal model is configured to forecast, from the outputs of the plurality of temperature sensors during a loading and/or unloading process, a temperature of the object to be processed contained in the processing container during the loading and/or unloading process and a temperature of the at least one other predetermined portion in the processing container during the loading and/or unloading process,

a desired temperature of the object to be processed during the loading and/or unloading process and a desired temperature of the predetermined portion during the loading and/or unloading process are defined in the recipe, and

the controlling part is adapted to forecast a temperature of the object to be processed during the loading and/or unloading process and a temperature of the predetermined portion during the loading and/or unloading process by using the outputs of the plurality of temperature sensors and the thermal model, and to control the plurality of heaters so as to cause the forecasted temperature of the object to be processed and the forecasted temperature of the predetermined portion to respectively coincide with the desired temperature of the object to be processed during the loading and/or unloading process and the desired temperature of the predetermined portion during the loading and/or unloading process defined in the recipe.

12. A thermal processing method of controlling a thermal processing apparatus including:

a processing container for containing an object to be processed,

a plurality of heaters for heating the object to be processed, and

a plurality of temperature sensors for respectively detecting temperatures at a plurality of predetermined positions in the processing container,

the thermal processing method comprising:

a forecasting step of forecasting a temperature of the object to be processed and a temperature of at least one other predetermined portion in the processing container by applying outputs of the plurality of temperature sensors to a thermal model that has been set in advance, and

a controlling step of controlling the plurality of heaters so as to cause the forecasted temperature of the object to be processed and the forecasted temperature of the predetermined portion to respectively coincide with a desired temperature of the object to be processed and a desired temperature of the predetermined portion that have been defined in advance.

13. A program for controlling a thermal processing apparatus including:

a processing container for containing an object to be processed,

a plurality of heaters for heating the object to be processed, and

a plurality of temperature sensors for respectively detecting temperatures at a plurality of predetermined positions in the processing container,

the program being adapted to cause a computer to execute:

a forecasting step of forecasting a temperature of the object to be processed and a temperature of at least one other predetermined portion in the processing container by applying outputs of the plurality of temperature sensors to a thermal model that has been set in advance, and

a controlling step of controlling the plurality of heaters so as to cause the forecasted temperature of the object to be processed and the forecasted temperature of the predetermined portion to respectively coincide with a desired temperature of the object to be processed and a desired temperature of the predetermined portion that have been

defined in advance.

14. A storage medium capable of being read by a computer, storing a program for controlling a thermal processing apparatus including:

a processing container for containing an object to be processed,

a plurality of heaters for heating the object to be processed, and

a plurality of temperature sensors for respectively detecting temperatures at a plurality of predetermined positions in the processing container,

the program being adapted to cause a computer to execute:

a forecasting step of forecasting a temperature of the object to be processed and a temperature of at least one other predetermined portion in the processing container by applying outputs of the plurality of temperature sensors to a thermal model that has been set in advance, and

a controlling step of controlling the plurality of heaters so as to cause the forecasted temperature of the object to be processed and the forecasted temperature of the predetermined portion to respectively coincide with a desired temperature of the object to be processed and a desired temperature of the predetermined portion that have been defined in advance.

15. A controlling unit for controlling a thermal processing apparatus including:

a processing container for containing an object to be processed,

a plurality of heaters for heating the object to be processed, and

a plurality of temperature sensors for respectively detecting temperatures at a plurality of predetermined positions in the processing container,

the controlling unit comprising:

a storing part that stores: a thermal model for forecasting a temperature of the object to be processed contained in the processing container from outputs of the plurality of temperature sensors, and a recipe in which a desired temperature of the object to be processed is defined, and

a controlling part that forecasts a temperature of the object to be

processed by using the outputs of the plurality of temperature sensors and the thermal model, and that controls the plurality of heaters so as to cause the forecasted temperature of the object to be processed to coincide with the desired temperature of the object to be processed defined in the recipe,

wherein

the thermal model is configured to forecast, from the outputs of the plurality of temperature sensors, not only a temperature of the object to be processed contained in the processing container but also a temperature of at least one other predetermined portion in the processing container,

a desired temperature of the predetermined portion is also defined in the recipe, and

the controlling part is adapted to forecast a temperature of the object to be processed and a temperature of the predetermined portion by using the outputs of the plurality of temperature sensors and the thermal model, and to control the plurality of heaters so as to cause the forecasted temperature of the object to be processed and the forecasted temperature of the predetermined portion to respectively coincide with the desired temperature of the object to be processed and the desired temperature of the predetermined portion defined in the recipe.

16. A program executed by a computer system including at least a computer, in order to materialize in the computer system a controlling unit,

the controlling unit being adapted to control a thermal processing apparatus including: a processing container for containing an object to be processed, a plurality of heaters for heating the object to be processed, and a plurality of temperature sensors for respectively detecting temperatures at a plurality of predetermined positions in the processing container,

the controlling unit comprising:

a storing part that stores: a thermal model for forecasting a temperature of the object to be processed contained in the processing container from outputs of the plurality of temperature sensors, and a recipe in which a desired temperature of the object to be processed is

defined, and

a controlling part that forecasts a temperature of the object to be processed by using the outputs of the plurality of temperature sensors and the thermal model, and that controls the plurality of heaters so as to cause the forecasted temperature of the object to be processed to coincide with the desired temperature of the object to be processed defined in the recipe,

wherein

the thermal model is configured to forecast, from the outputs of the plurality of temperature sensors, not only a temperature of the object to be processed contained in the processing container but also a temperature of at least one other predetermined portion in the processing container,

a desired temperature of the predetermined portion is also defined in the recipe, and

the controlling part is adapted to forecast a temperature of the object to be processed and a temperature of the predetermined portion by using the outputs of the plurality of temperature sensors and the thermal model, and to control the plurality of heaters so as to cause the forecasted temperature of the object to be processed and the forecasted temperature of the predetermined portion to respectively coincide with the desired temperature of the object to be processed and the desired temperature of the predetermined portion defined in the recipe.

17. A program including a command for controlling a second program operable in a computer system including at least a computer,

the program being executed by the computer system to control the second program to materialize in the computer system a controlling unit,

the controlling unit being adapted to control a thermal processing apparatus including: a processing container for containing an object to be processed, a plurality of heaters for heating the object to be processed, and a plurality of temperature sensors for respectively detecting temperatures at a plurality of predetermined positions in the processing container,

the controlling unit comprising:

a storing part that stores: a thermal model for forecasting a temperature of the object to be processed contained in the processing container from outputs of the plurality of temperature sensors, and a recipe in which a desired temperature of the object to be processed is defined, and

a controlling part that forecasts a temperature of the object to be processed by using the outputs of the plurality of temperature sensors and the thermal model, and that controls the plurality of heaters so as to cause the forecasted temperature of the object to be processed to coincide with the desired temperature of the object to be processed defined in the recipe,

wherein

the thermal model is configured to forecast, from the outputs of the plurality of temperature sensors, not only a temperature of the object to be processed contained in the processing container but also a temperature of at least one other predetermined portion in the processing container,

a desired temperature of the predetermined portion is also defined in the recipe, and

the controlling part is adapted to forecast a temperature of the object to be processed and a temperature of the predetermined portion by using the outputs of the plurality of temperature sensors and the thermal model, and to control the plurality of heaters so as to cause the forecasted temperature of the object to be processed and the forecasted temperature of the predetermined portion to respectively coincide with the desired temperature of the object to be processed and the desired temperature of the predetermined portion defined in the recipe.

18. A storage medium capable of being read by a computer, storing a program,

the program being executed by a computer system including at least a computer in order to materialize in the computer system a controlling unit,

the controlling unit being adapted to control a thermal processing apparatus including: a processing container for containing an object to be processed, a plurality of heaters for heating the object to be

processed, and a plurality of temperature sensors for respectively detecting temperatures at a plurality of predetermined positions in the processing container,

the controlling unit comprising:

a storing part that stores: a thermal model for forecasting a temperature of the object to be processed contained in the processing container from outputs of the plurality of temperature sensors, and a recipe in which a desired temperature of the object to be processed is defined, and

a controlling part that forecasts a temperature of the object to be processed by using the outputs of the plurality of temperature sensors and the thermal model, and that controls the plurality of heaters so as to cause the forecasted temperature of the object to be processed to coincide with the desired temperature of the object to be processed defined in the recipe,

wherein

the thermal model is configured to forecast, from the outputs of the plurality of temperature sensors, not only a temperature of the object to be processed contained in the processing container but also a temperature of at least one other predetermined portion in the processing container,

a desired temperature of the predetermined portion is also defined in the recipe, and

the controlling part is adapted to forecast a temperature of the object to be processed and a temperature of the predetermined portion by using the outputs of the plurality of temperature sensors and the thermal model, and to control the plurality of heaters so as to cause the forecasted temperature of the object to be processed and the forecasted temperature of the predetermined portion to respectively coincide with the desired temperature of the object to be processed and the desired temperature of the predetermined portion defined in the recipe.

19. A storage medium capable of being read by a computer, storing a program,

the program including a command for controlling a second program operable in a computer system including at least a computer,

the program being executed by the computer system to control the second program to materialize in the computer system a controlling unit,

the controlling unit being adapted to control a thermal processing apparatus including: a processing container for containing an object to be processed, a plurality of heaters for heating the object to be processed, and a plurality of temperature sensors for respectively detecting temperatures at a plurality of predetermined positions in the processing container,

the controlling unit comprising:

a storing part that stores: a thermal model for forecasting a temperature of the object to be processed contained in the processing container from outputs of the plurality of temperature sensors, and a recipe in which a desired temperature of the object to be processed is defined, and

a controlling part that forecasts a temperature of the object to be processed by using the outputs of the plurality of temperature sensors and the thermal model, and that controls the plurality of heaters so as to cause the forecasted temperature of the object to be processed to coincide with the desired temperature of the object to be processed defined in the recipe,

wherein

the thermal model is configured to forecast, from the outputs of the plurality of temperature sensors, not only a temperature of the object to be processed contained in the processing container but also a temperature of at least one other predetermined portion in the processing container,

a desired temperature of the predetermined portion is also defined in the recipe, and

the controlling part is adapted to forecast a temperature of the object to be processed and a temperature of the predetermined portion by using the outputs of the plurality of temperature sensors and the thermal model, and to control the plurality of heaters so as to cause the forecasted temperature of the object to be processed and the forecasted temperature of the predetermined portion to respectively coincide with the desired temperature of the object to be processed and the desired

temperature of the predetermined portion defined in the recipe.